US011510348B2

(12) **United States Patent**
Yamauchi

(10) **Patent No.: US 11,510,348 B2**
(45) **Date of Patent: Nov. 22, 2022**

(54) **SHIELD CASE**

(71) Applicant: **LAPIS SEMICONDUCTOR CO., LTD.**, Yokohama (JP)

(72) Inventor: **Shigeki Yamauchi**, Yokohama (JP)

(73) Assignee: **LAPIS SEMICONDUCTOR CO., LTD.**, Yokohama (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 58 days.

(21) Appl. No.: **17/210,578**

(22) Filed: **Mar. 24, 2021**

(65) **Prior Publication Data**

US 2021/0307220 A1 Sep. 30, 2021

(30) **Foreign Application Priority Data**

Mar. 27, 2020 (JP) JP2020-057113

(51) **Int. Cl.**
H05K 9/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H05K 9/0028*** (2013.01)

(58) **Field of Classification Search**
CPC H05K 9/0028
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,400,949	A *	3/1995	Hirvonen	H05K 9/003 228/180.1
7,138,584	B1 *	11/2006	Ju	H05K 3/341 174/384
D945,384	S *	3/2022	Yamauchi	D13/182
2002/0057560	A1 *	5/2002	Okada	H05K 9/0028 29/762
2005/0254224	A1 *	11/2005	Fagrenius	H05K 3/341 361/800
2007/0291464	A1 *	12/2007	Wang	H05K 9/0028 361/820
2009/0184405	A1 *	7/2009	Lu	H01L 23/552 257/E23.114
2010/0061066	A1 *	3/2010	Guan	H05K 9/0026 361/752
2013/0322040	A1 *	12/2013	Watanabe	H05K 9/0024 361/760

(Continued)

FOREIGN PATENT DOCUMENTS

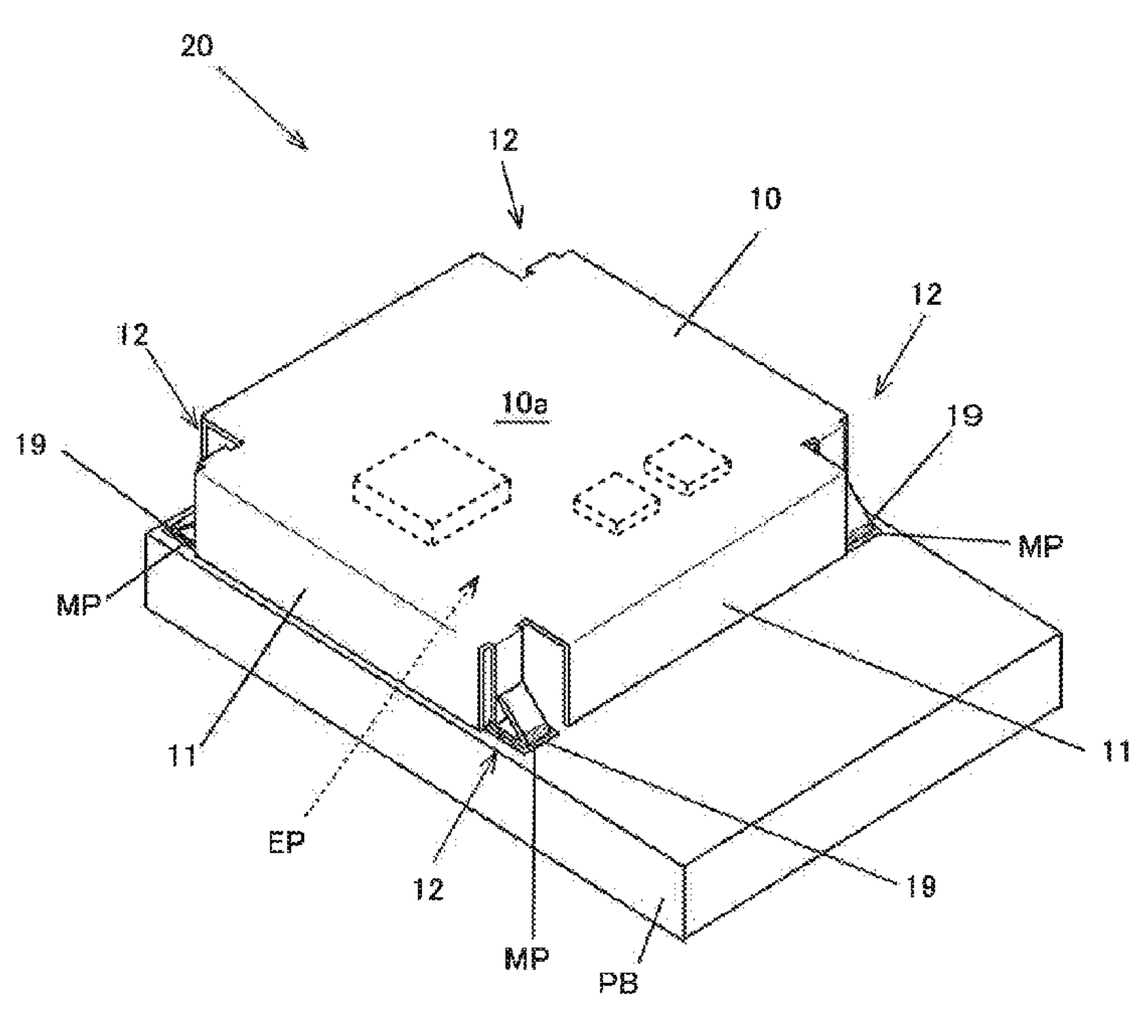
JP 2016114695 A 6/2016

Primary Examiner — Hung V Ngo
(74) *Attorney, Agent, or Firm* — Volentine, Whitt & Francos, PLLC

(57) **ABSTRACT**

A shield case for covering an electronic component includes a top panel portion made of a metal plate, a plurality of terminal leg portions formed to project in a direction intersecting with the top panel portion from a peripheral edge portion thereof, and a side plate portion formed to project in the direction intersecting with the top panel portion from a peripheral edge portion of the top panel portion other than the plurality of terminal leg portions. Each of the plurality of terminal leg portions includes a leg portion that stretches from the top panel portion, a joint portion that extends in a direction intersecting with the leg portion from a distal end of the leg portion, and a terminal portion with a ring-shaped cross-sectional surface that has a projecting support abutting on the leg portion from a distal end of the joint portion.

10 Claims, 11 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2013/0329381	A1*	12/2013	Huang	H05K 9/0028 361/748
2017/0202115	A1*	7/2017	Saito	H05K 9/0028
2017/0311438	A1*	10/2017	Khorrami	H05K 1/18
2021/0307154	A1*	9/2021	Nakamura	H05K 3/3442

* cited by examiner

Fig. 1

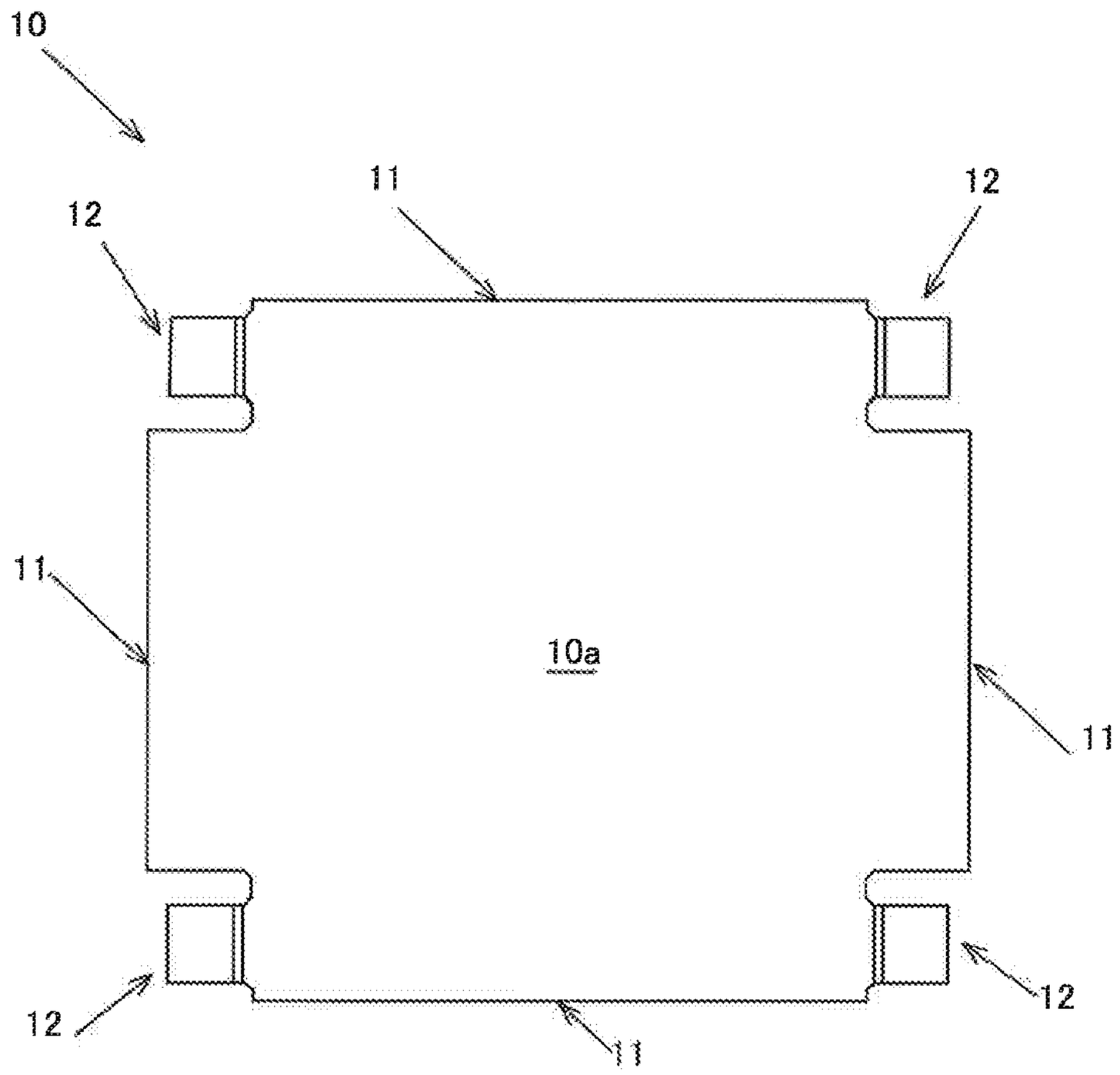

10
11
12
12
11
10a
11
12
11

Fig. 2

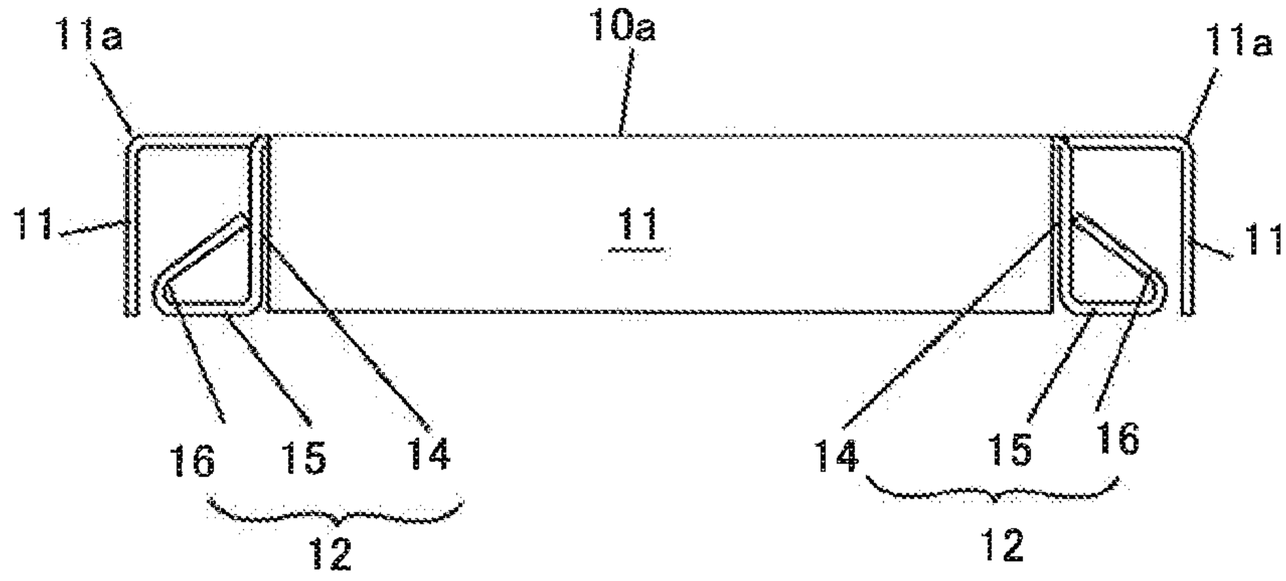

11a
10a
11a
11
11
11
16
15
14
14
15
16
12
12
TRIANGULAR RING-SHAPED TERMINAL
TRIANGULAR RING-SHAPED TERMINAL

Fig. 3

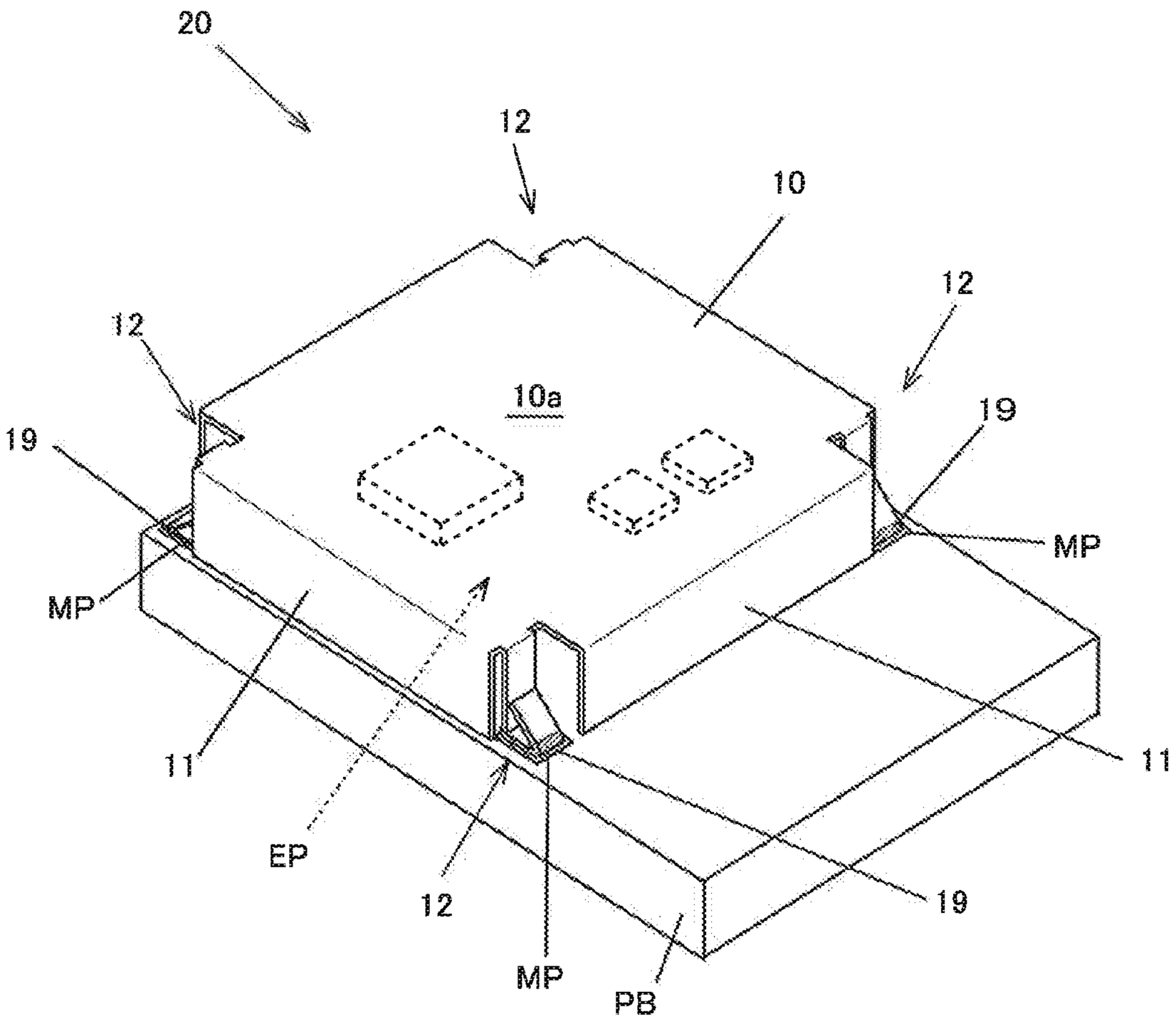


Fig. 4

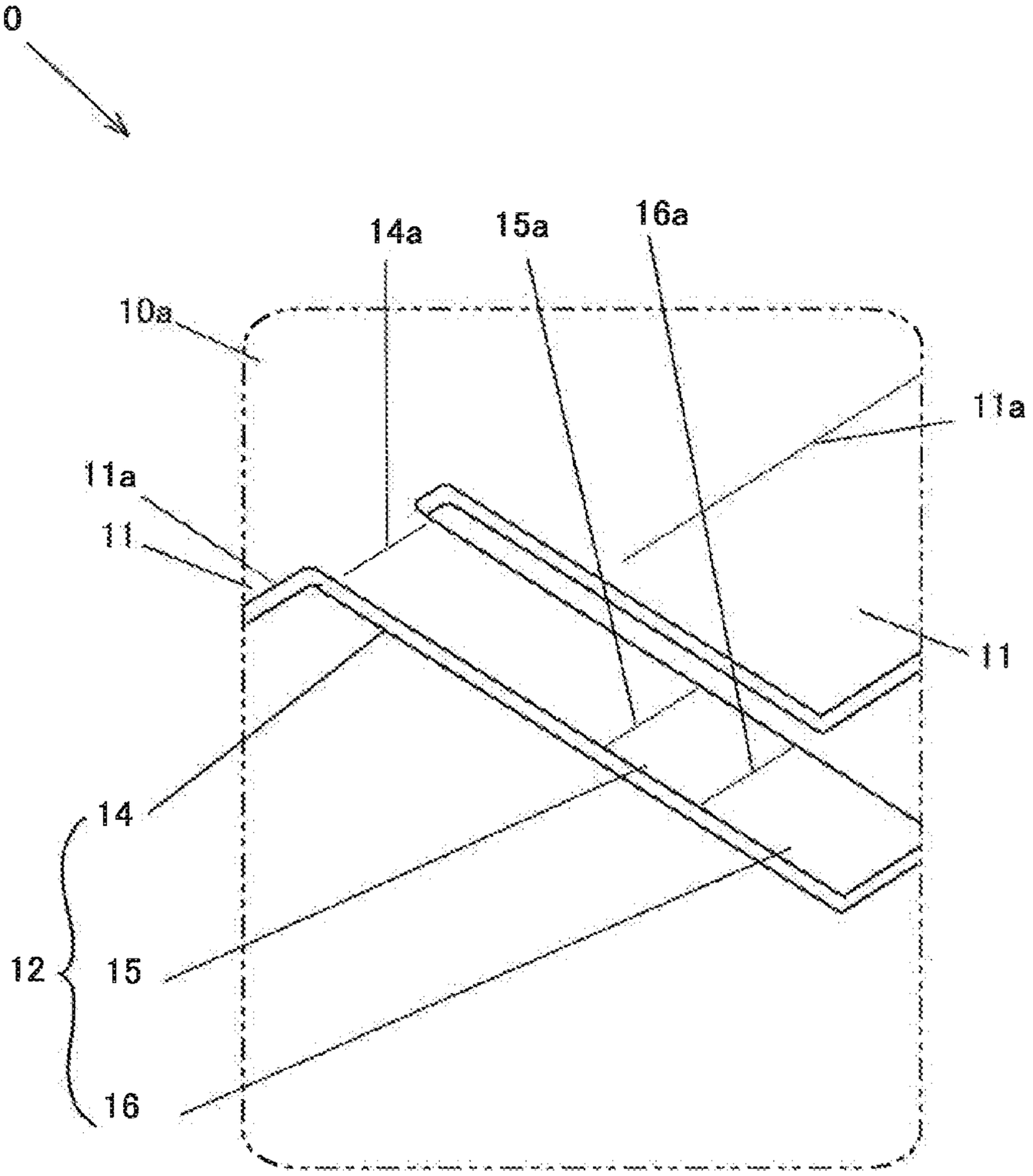


Fig. 5

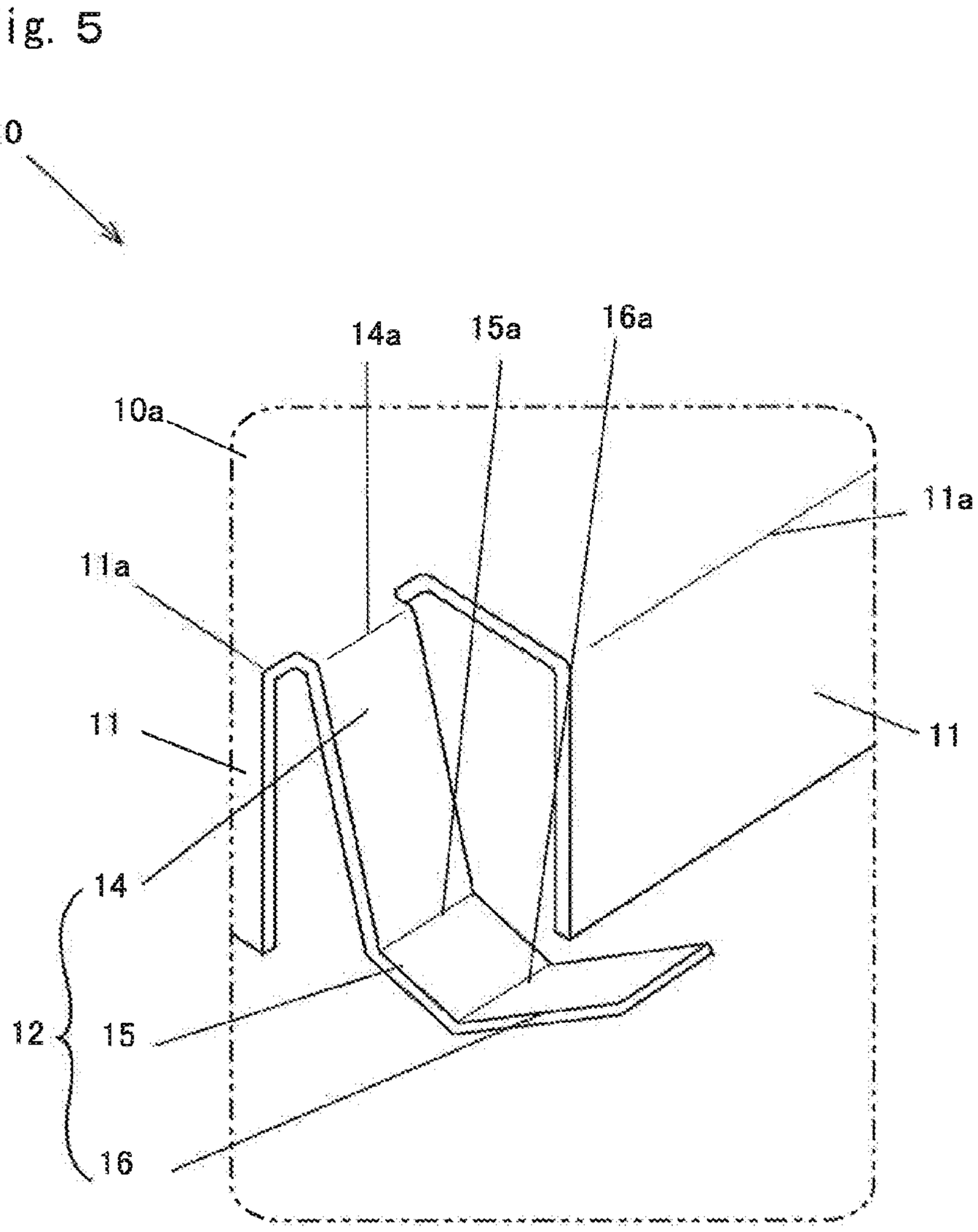


Fig. 6

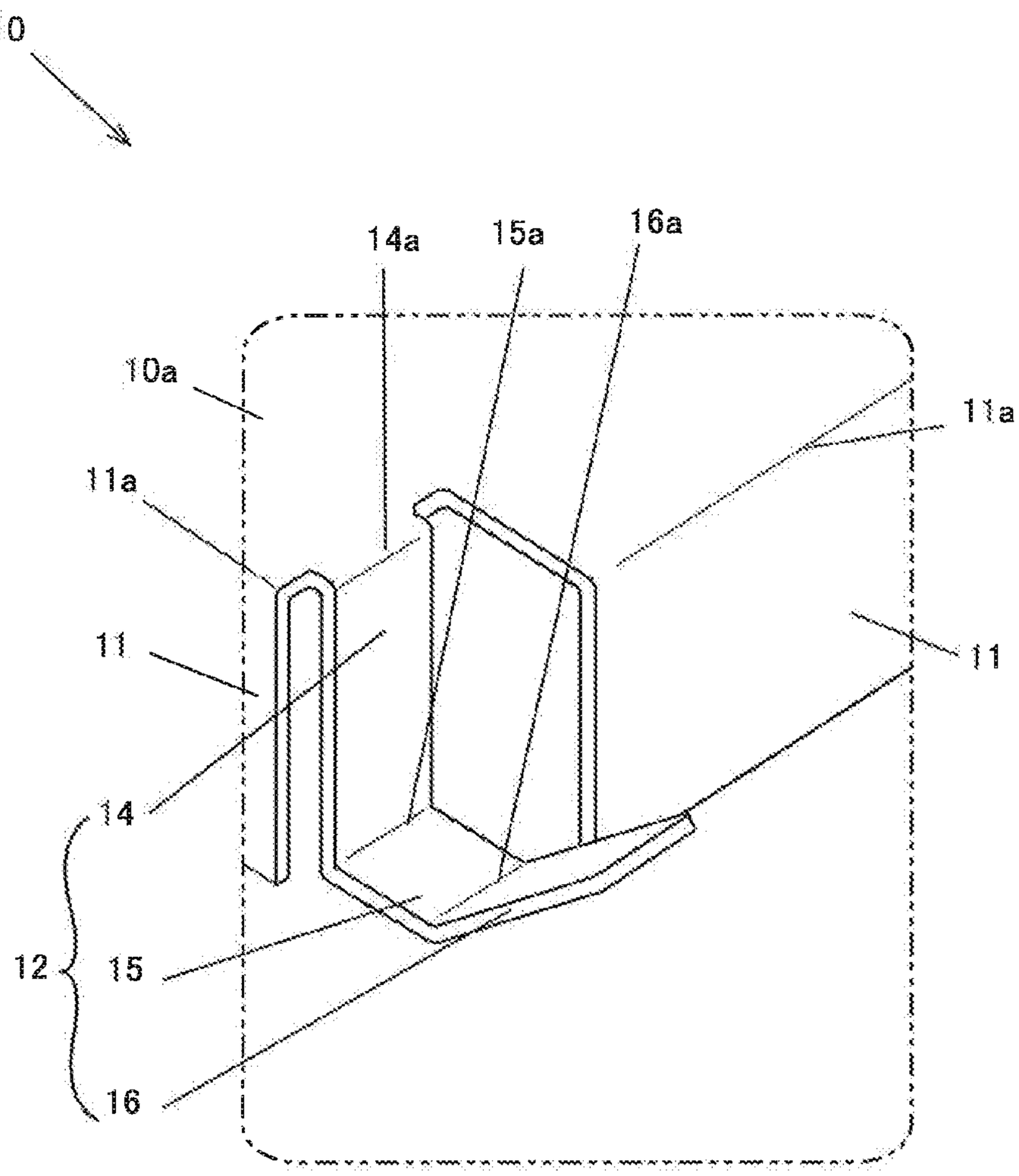


Fig. 7

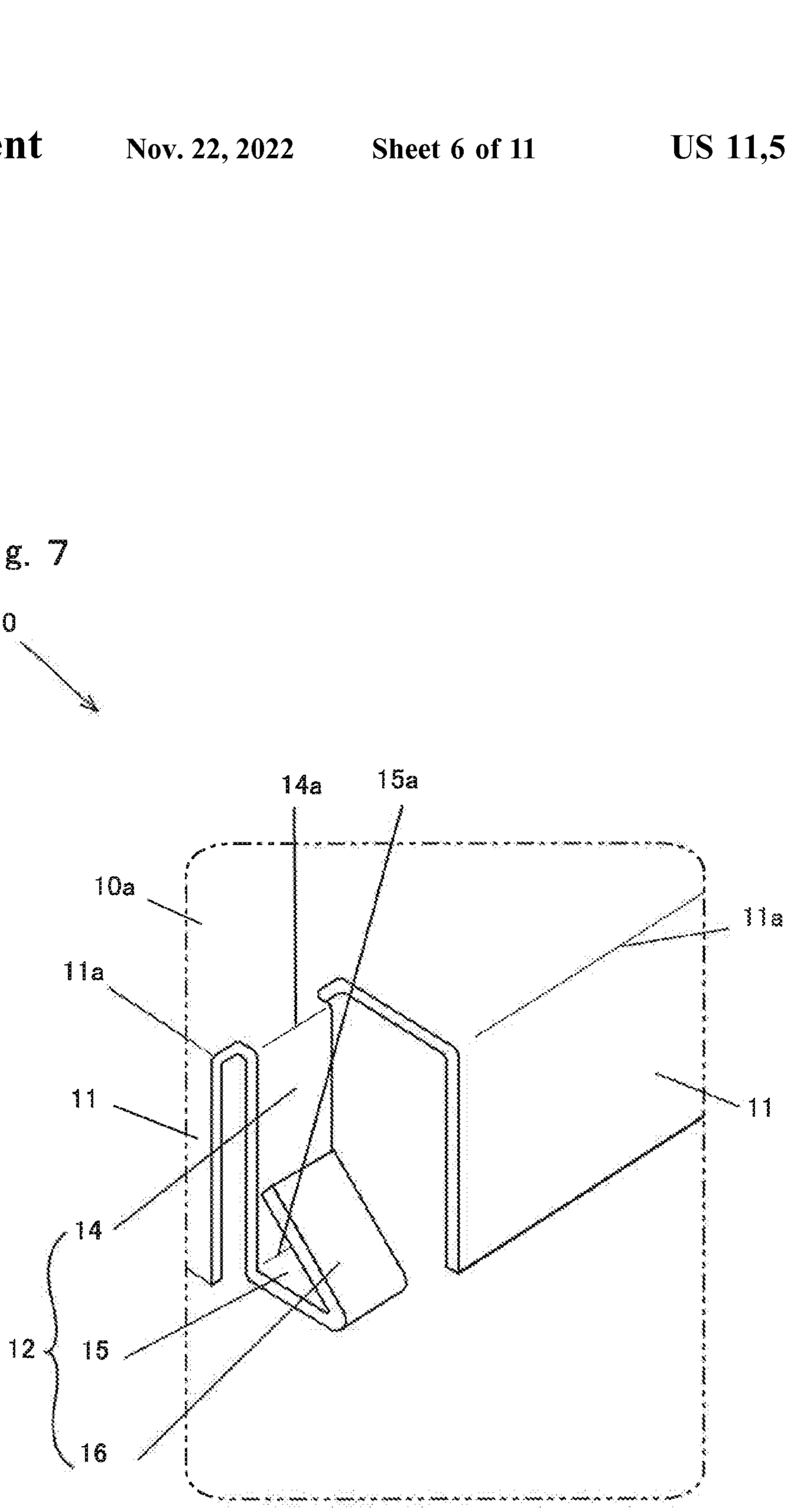


Fig. 8

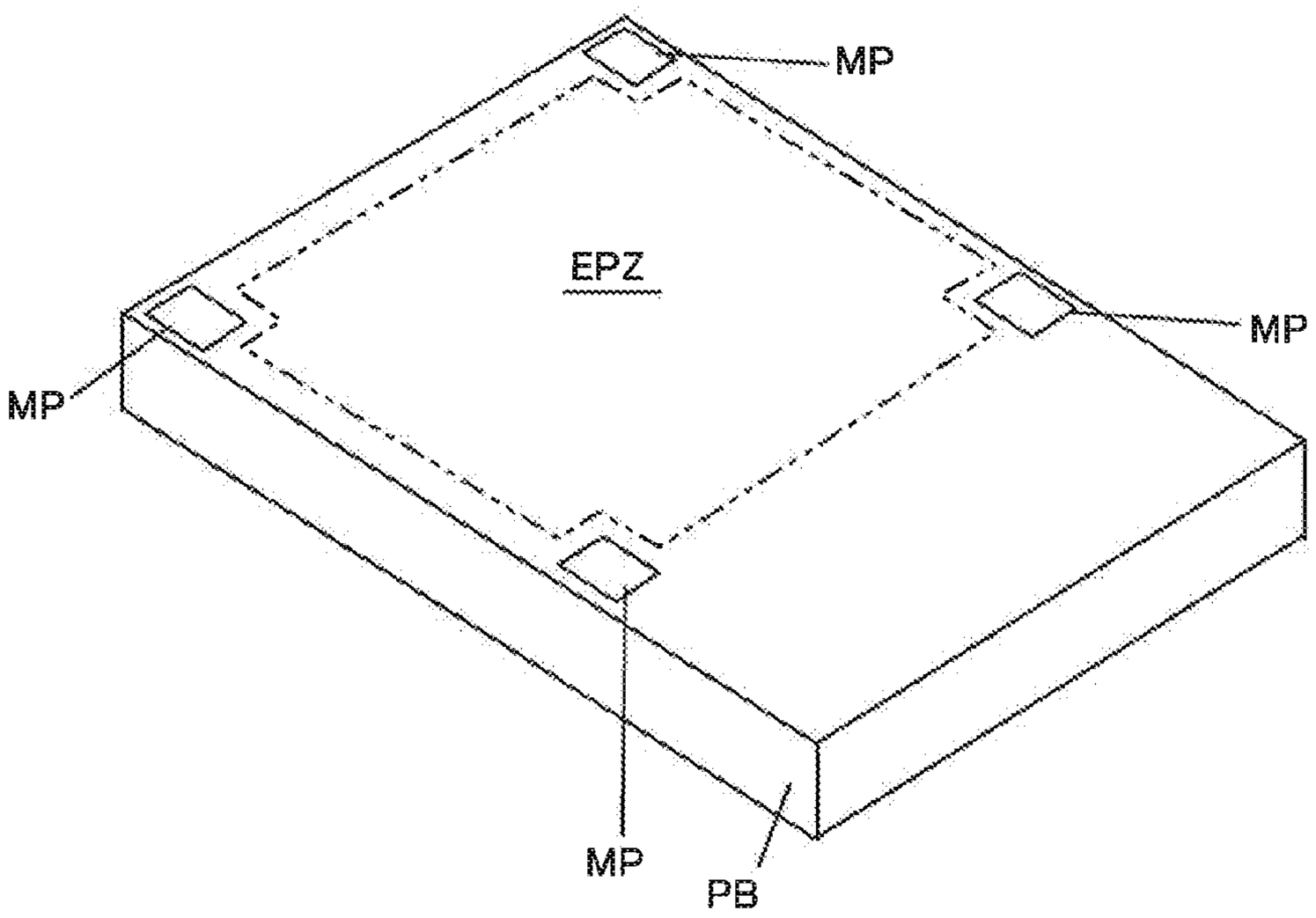


Fig. 9

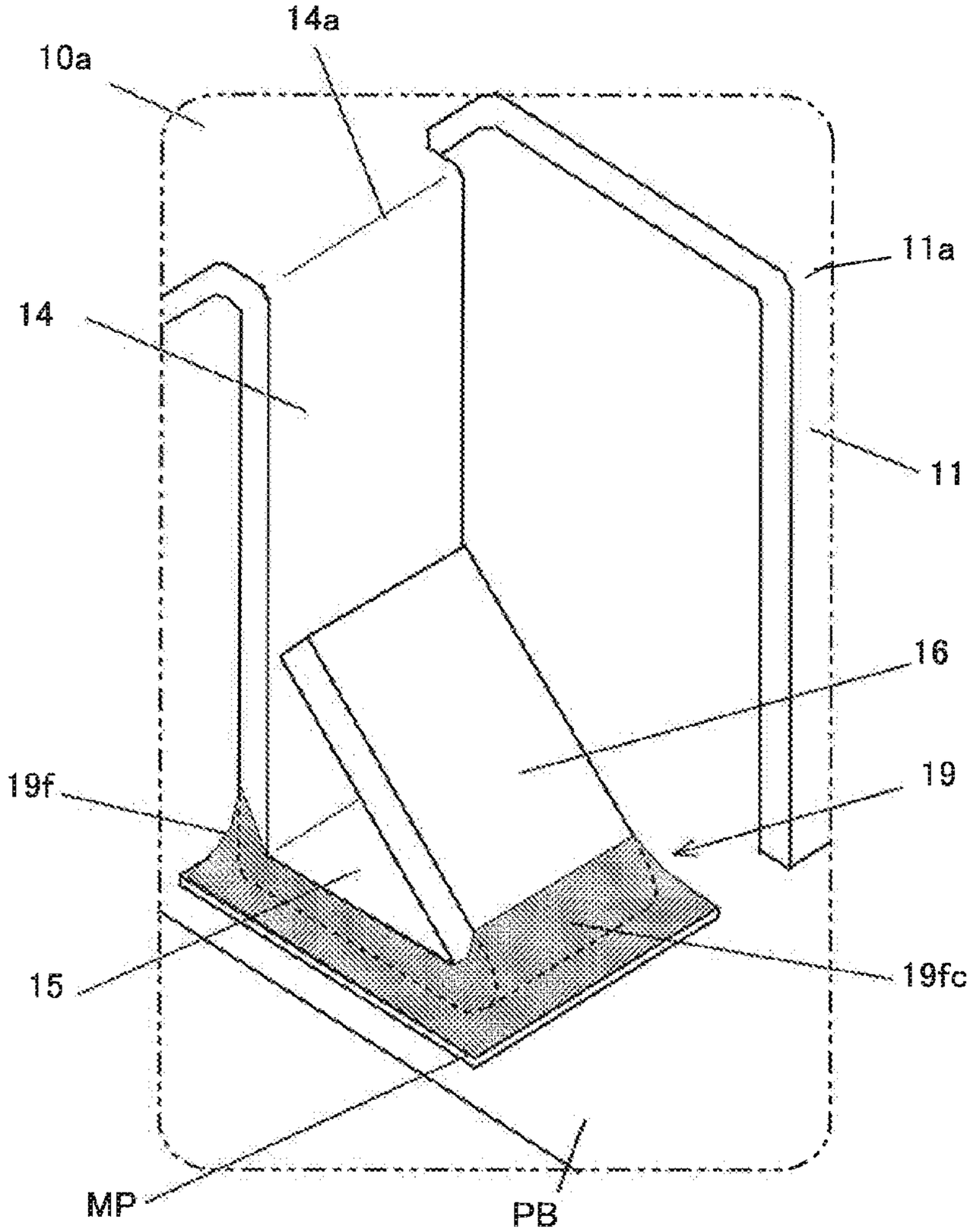


Fig. 10

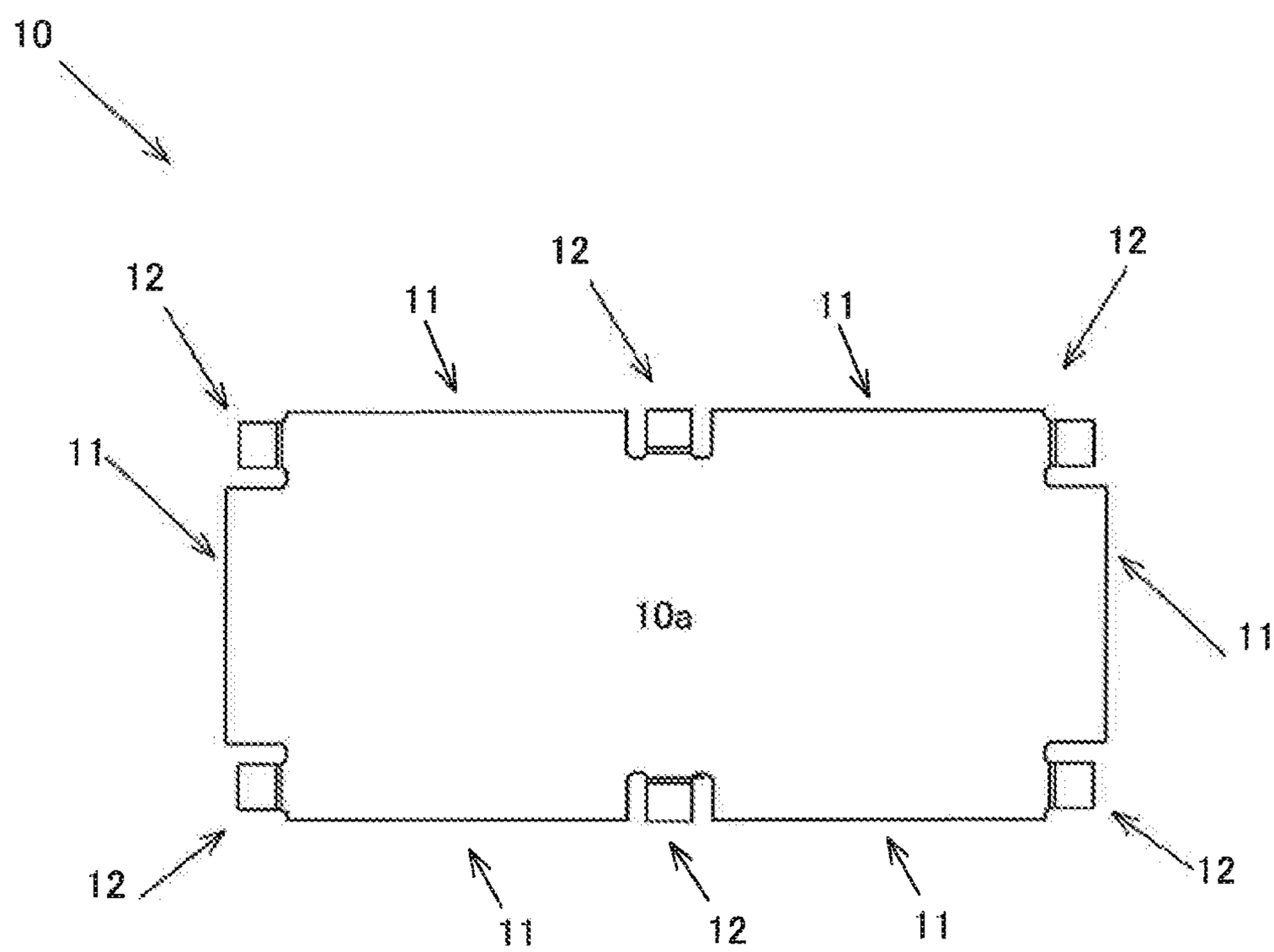


Fig. 11

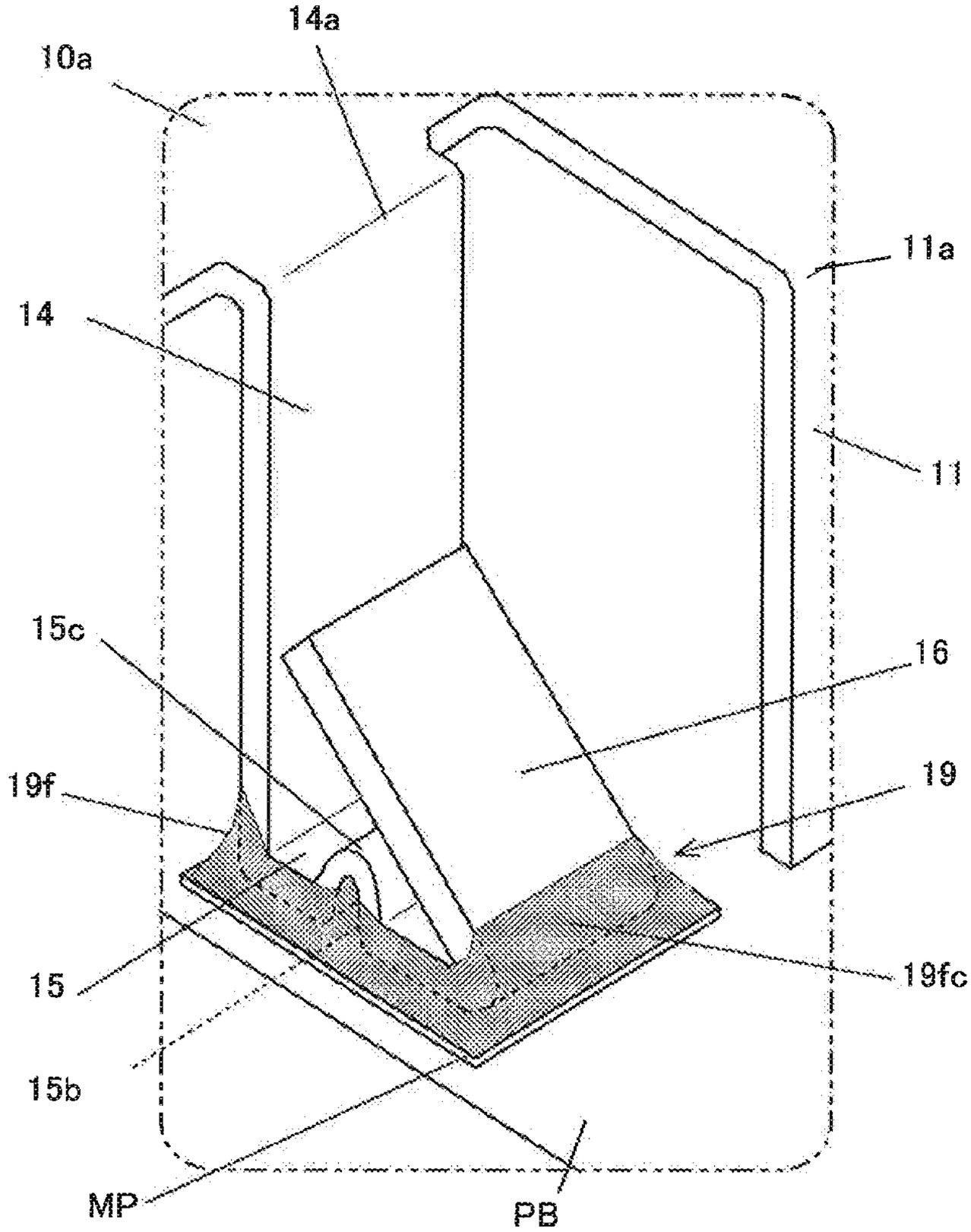
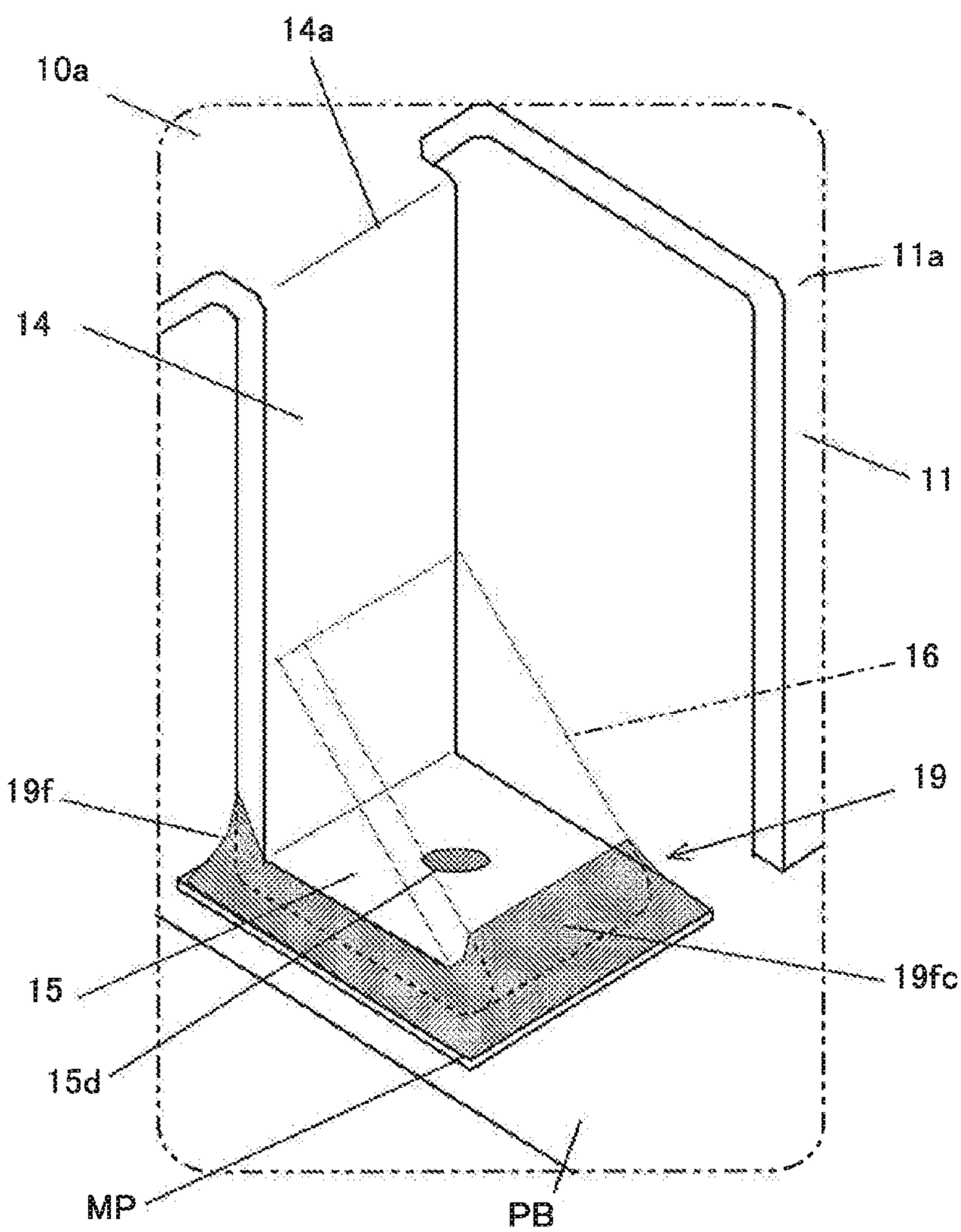


Fig. 12



SHIELD CASE

CROSS-REFERENCE TO RELATED APPLICATION

This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2020-057113 filed on Mar. 27, 2020, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to a shield case installed on a printed substrate.

2. Description of the Related Art

In recent years, radio communication equipment has been desired to be usable under any environmental conditions and has been increasingly requested to reduce its size so as to be compact and easily portable and usable.

An electronic circuit module, such as a wireless module, internally mounted in the radio communication equipment is required to be shielded with a shield case, such as a metallic case, as a compatibility condition in, for example, a radio wave authentication. It is also desired a shield case that covers an electronic component installed on a printed substrate (hereinafter also referred to as a substrate) for a protection of an internal circuit of the electronic circuit module, anti-noise measures, and the like. For example, a shield case has a cubic box structure without a solder connection terminal and has a structure in which the shield case is mounted on the substrate and four side surfaces of the shield case are attached to the substrate by soldering (see JP-A-2016-114695).

SUMMARY OF THE INVENTION

There sometimes occurs a contraction or a warpage of the substrate when the radio communication equipment is used in the environment of drastic temperature change, or an impact generated when the equipment is dropped while it is carried around, a bending warpage and the like generated when the electronic circuit module is placed in a space with no room, which applies a large stress on a solder joint portion of a shield case and results in sometimes a defect of delamination of a joint portion.

The related art takes the measures to increase connection strength by increasing soldering portions of the shield case in order to solve the above-described failure of delamination. To increase the soldering portions, it is necessary to reduce a component area on the substrate or increase an outside dimension of the substrate. Furthermore, disadvantages such as an increased usage of solder for installing the shield case and an increased time of solder condition inspection of the solder joint portion are generated.

Additionally, what is called a shield case delamination, which is the delamination of the shield case from the substrate, has also occurred due to the lack of portions from which the stress escapes when the substrate warps because the solder joint portions are excessively increased.

The present invention has been made in consideration of the above-described problems, and it is an object of the present invention to provide a shield case that reduces the disadvantages of the related art and improve a problem of shield case delamination from a substrate.

A shield case according to the present invention is a shield case for covering an electronic component. The shield case includes a top panel portion, a plurality of terminal leg portions, and a side plate portion. The top panel portion is made of a metal plate. The plurality of terminal leg portions are formed to project in a direction intersecting with the top panel portion from a peripheral edge portion of the top panel portion. The side plate portion is formed to project in the direction intersecting with the top panel portion from a peripheral edge portion of the top panel portion other than the plurality of terminal leg portions. Each of the plurality of terminal leg portions includes a leg portion that stretches from the top panel portion, a joint portion that extends in a direction intersecting with the leg portion from a distal end of the leg portion, and a terminal portion with a ring-shaped cross-sectional surface that includes a projecting support abutting on the leg portion from a distal end of the joint portion.

The present invention ensures achieving the improved problem of shield case delamination from a substrate in an assembly of the substrate and the shield case.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top view of a shield case in a first embodiment according to the present invention;

FIG. **2** is a side view of the shield case in the first embodiment;

FIG. **3** is a perspective view illustrating an electronic circuit module in which the shield case in the first embodiment is installed on a substrate;

FIGS. **4** to **7** are perspective views of proximity of a terminal leg portion of the shield case to illustrate a sheet metal processing operation for the shield case in the first embodiment;

FIG. **8** is a perspective view of the substrate on which the shield case in the first embodiment is to be installed;

FIG. **9** is a perspective view of proximity of the terminal leg portion of the shield case in the first embodiment;

FIG. **10** is a top view of a shield case of a modification in the first embodiment according to the present invention;

FIG. **11** is a perspective view of proximity of a terminal leg portion of a shield case in a second embodiment; and

FIG. **12** is a perspective view of proximity of a terminal leg portion of a shield case in a third embodiment.

DETAILED DESCRIPTION OF THE INVENTION

The following describes embodiments according to the present invention in detail with reference to the drawings. Note that, in the embodiments, components having substantially identical functions and configurations are attached by identical reference numerals to omit repeated explanations.

First Embodiment

FIG. **1** is a top view of a shield case **10** made of metal, such as copper, iron, or alloy, of a first embodiment. FIG. **2** is a side view of the shield case **10**.

FIG. **3** is a perspective view of illustrating an electric circuit module (hereinafter also referred to as a module) **20**, such as a wireless module, that includes the shield case **10**. The module **20** is configured of a substrate PB on which various kinds of electronic components EP configuring an

electric circuit are mounted and the shield case **10** that covers the components and is installed on the electric circuit via a solder **19**.

The shield case **10** includes a rectangular top panel **10***a*, side plate portions **11** as sidewall sets of two opposed sides, and terminal leg portions **12** offset and formed on four corners of the top panel **10***a*, and has an approximately cuboid shape with a side of the substrate PB opened. A plurality of the four terminal leg portions each include a leg portion **14** that stretches in the normal direction from the top panel **10***a*, a joint portion **15** that extends in a direction intersecting with the leg portion **14** from a distal end of the leg portion **14**, and a projecting support **16** that abuts on the leg portion **14** from a distal end of the joint portion **15**. These leg portion **14**, joint portion **15**, and projecting support **16** configure a terminal portion with a ring-shaped vertical cross-section.

[Manufacturing Method of Shield Case]

The shield case **10** is formed from a metallic plate by sheet metal processing. FIG. **4** to FIG. **7** are perspective views illustrating proximity of the terminal leg portion **12** to illustrate a sheet metal processing operation for the shield case **10**. As illustrated in FIG. **4**, the shield case **10** is formed from a metallic plate having the top panel **10***a*, a strip-shaped portion (the leg portion **14**, the joint portion **15**, and the projecting support **16**) that serves as the terminal leg portion projecting out of the top panel **10***a*, and a strip-shaped portion (the side plate portion **11**) that serves as the side plate portion by folding outward each of the strip-shaped portions in a direction intersecting with the top panel **10***a*.

The side plate portions **11** are orthogonally bent outward with respect to the top panel **10***a* at mountain fold lines **11***a* to be formed to have a predetermined height as illustrated in FIG. **5**.

Each of the terminal leg portions **12** are formed as follows. For example, as illustrated in FIG. **5** and FIG. **6**, the terminal leg portion **12** is orthogonally bent outward with respect to the top panel **10***a* at a mountain fold line **14***a*, its distal end is orthogonally bent at a first valley fold line **15***a* to form a portion of the leg portion **14** having a predetermined height. The predetermined heights of the side plate portion **11** and the leg portion **14** are set higher than a height of the electronic components so as to keep a space between the shield case **10** and the electronic components (not illustrated) covered by the shield case **10**. However, the predetermined height of the side plate portion **11** is less than the predetermined height of the leg portion **14**.

Next, as illustrated in FIG. **6** and FIG. **7**, a portion between the first and a second valley fold line **15***a* and **16***a* is further bent at the second valley fold line **16***a* to form the joint portion **15** with a bottom having a predetermined flat joint surface to be solder joined. The projecting support **16** is formed by being further bent at the second valley fold line **16***a* and a ring its distal end brought into contact with the leg portion **14**. Performing the above-described process on each of these terminal leg portions **12** form a triangular ring-shaped terminal portion having a triangular ring-shaped vertical cross-section configured of the leg portion **14**, the joint portion **15**, and the projecting support **16**, and thus, the shield case **10** is completed.

[Module Assembly]

FIG. **8** is a perspective view of the substrate PB before assembling the module. On the substrate PB, metal pads MP made of conductor patterns are arranged and formed to correspond to the joint portions **15** located on the four corners of the shield case **10**. The shield case **10** is installed on the metal pads MP via solder. The metal pad MP has its joint surface larger than a size of the joint portion **15** and is installed at a position where the joint portion **15** does not protrude out. For dimensions of the metal pad MP, a certain area size of the metal pad MP is required for a manufacturing tolerance of the shield case **10** and forming appropriate solder fillets outside and inside the joint portion **15**. The metal pad MP can be arranged at, for example, approximately 0.3 mm away from an end of the substrate PB. As illustrated in FIG. **7**, an electronic component mounted area EPZ, which the shield case **10** excluding the four corners for the four metal pads MP covers, is secured.

For example, placing the respective terminal leg portions **12** of the shield case **10** on the respective metal pads MP via a solder paste (not illustrated) and performing reflow for solder joining ensure obtaining the module **20** in which the shield case **10** is installed on the substrate PB illustrated in FIG. **3**.

[Operation]

FIG. **9** is a perspective view of proximity of the terminal leg portion **12** of the shield case **10**. During solder heating, such as the reflow, the melt solder **19** spreads between the joint portion **15** and the metal pad MP. Since the size of the joint portion **15** is smaller than the size of the metal pad MP, a solder fillet **19***f* is formed around the joint portion **15**. Furthermore, the triangular ring-shaped structure forms not only the solder fillet **19***f* at a side of the leg portion **14** but also a solder fillet **19***fc* spread over to an outer curved side surface of the projecting support **16** on the opposite side.

According to this embodiment, since the projecting support **16** that continues from the joint portion **15** and brought into contact with the leg portion **14** is disposed, a joint area of the solder is increased by the solder fillet **19***fc* in contact with the projecting support **16**. This ensures increasing the joining strength of the shield case **10**.

For example, when the module **20** at the product shipping is placed in a test socket for module (not illustrated) and the top panel **10***a* is pressed toward the substrate PB, the large stress concentrates near the portion of the leg portion **14** of the shield case **10**. According to this embodiment, even though the leg portion **14** bends, the distal-end of the projecting support **16** serves as a support of the leg portion **14** to disperse the stress, thereby providing an effect of reducing the deformation of the leg portion **14** of the shield case **10**.

Thus, forming the terminal portion structure of the terminal leg portion **12** on the four corner of the shield case **10** into the ring-shaped structure increases the mechanical strength, thereby providing an effect of reducing the shield case delamination. There also is an advantage of eliminating the necessity of changing the metal pad MP of the substrate PB into peculiar shape and size in particular.

Generally, when the outside dimension of the module is desired to be decreased or when the shield case **10** is desired to be in a peculiar shape, it is necessary to thin the thickness of the shield case **10** (the thickness of the material metal plate), but thinning the thickness of the shield case **10** reduces resistance of the mechanical strength. On the other hand, with the ring-shaped terminal portion of this embodiment, the thinner the thickness of the sheet metal for the shield case **10** is, the more effective it becomes in maintaining the strength.

As described above, according to this embodiment, the strength of the leg portion of the shield case **10** and the solder joining strength improve to ensure sufficiently hold-

ing the shield case **10**. Accordingly, this embodiment can contribute to downsize and densify the module **20** without increasing the cost.

[Modification]

While, in the above embodiment, the respective terminal leg portions **12** are disposed at the four corners of the shield case **10**, the installation position of the terminal leg portions **12** is not limited to this. That is, in a modification of this embodiment, a part of the terminal leg portions **12** may be formed in a middle portion between the corner portions of the shield case **10** as illustrated in the top view of the shield case illustrated in FIG. **10**.

Second Embodiment

FIG. **11** illustrates a perspective view of proximity of the terminal leg portion **12** in a main part of the shield case **10** in this second embodiment. The shield case **10** of this embodiment has the same configuration as that of the first embodiment except that the shape of the joint portion **15** of the shield case **10** is different with respect to the first embodiment as illustrated in FIG. **5**.

In the shield case in this embodiment, a projecting portion **15***c* that projects in a normal direction of the joint surface is disposed at the center of the joint portion **15** such that a groove that extends in a width direction of the joint surface of the joint portion **15**, that is, a depressed portion **15***b* is formed.

In the shield case of this embodiment, the solder is filled in the depressed portion **15***b* in addition to the solder fillet **19***f* around the joint portion **15** when solder joining is performed.

Since the solder **19** is filled in the depressed portion **15***b* of the joint portion **15**, in addition to the effect of the first embodiment, the joint area between the solder **19** and the shield case **10** (the joint portion **15**) increases, thereby ensuring further improved joining strength of the shield case **10**. Note that the number of the depressed portion **15***b* of the joint portion **15** may be plural, and a stretching direction of the depressed portion **15***b* can be conveniently set.

Third Embodiment

FIG. **12** illustrates a perspective view of proximity of the terminal leg portion **12** in a main part of the shield case **10** of this third embodiment (however, it is illustrated by the two-dot chain line in order to see through the projecting support **16**). The shield case **10** in this embodiment has the same configuration as that of the first embodiment except that the shape of the joint portion **15** of the shield case **10** is different with respect to the first embodiment as illustrated in FIG. **5**. In the shield case according to this embodiment, a through-hole **15***d* is provided in the center of the joint portion **15**.

In the shield case of this embodiment, the solder is filled in the through-hole **15***d* in addition to the solder fillet **19***f* around the joint portion **15** when the solder joining is performed.

Since the solder **19** is filled in the through-hole **15***d* of the joint portion **15**, in addition to the effect of the first embodiment, the joint area between the solder **19** and the shield case **10** (the joint portion **15**) increases, thereby ensuring further improved joining strength of the shield case **10**. That is, since the through-hole **15***d* is provided on the joint portion **15**, the solder fillet **19***f* formed on the inner peripheral wall increases, thereby ensuring further improved joining strength of the shield case **10**. Note that the number of the through-hole **15***d* of the joint portion **15** may be plural, and an arranging direction when a plurality of the through-holes **15***d* are provided can be conveniently set.

In any of the embodiments, the above-described shield case structure is applicable as a shield case installed on a rigid substrate or as a shield case installed on a flexible substrate. For example, the above-described shield case structure can be used for a module including a shield case that blocks a high frequency and a communication device, such as a smart phone and a portable information terminal, that uses the module.

What is claimed is:

1. A shield case for covering an electronic component, the shield case comprising:

a top panel portion made of a metal plate;

a plurality of terminal leg portions formed to project in a direction intersecting with the top panel portion from a peripheral edge portion of the top panel portion; and

a side plate portion formed to project in the intersecting with the top panel portion from a peripheral edge portion of the top panel portion other than the plurality of terminal leg portions, wherein

each of the plurality of terminal leg portions includes a leg portion that stretches from the top panel portion, a joint portion that extends in a direction intersecting with the leg portion from a distal end of the leg portion, and a terminal portion with a ring-shaped cross-sectional surface that includes a projecting support abutting on the leg portion from a distal end of the joint portion.

2. The shield case according to claim **1**, wherein

the joint portion of the terminal portion is a part to be solder joined.

3. The shield case according to claim **2**, wherein

the plurality of terminal leg portions are formed on respective corner portions of the shield case.

4. The shield case according to claim **3**, wherein

the joint portion of the terminal portion has a depressed portion.

5. The shield case according to claim **3**, wherein

the joint portion of the terminal portion has a through-hole.

6. The shield case according to claim **2**, wherein

a part of the plurality of terminal leg portions is formed in a middle portion between corner portions of the shield case.

7. The shield case according to claim **6**, wherein

the joint portion of the terminal portion has a depressed portion.

8. The shield case according to claim **6**, wherein

the joint portion of the terminal portion has a through-hole.

9. The shield case according to claim **2**, wherein

the joint portion of the terminal portion has a depressed portion.

10. The shield case according to claim **2**, wherein

the joint portion of the terminal portion has a through-hole.

* * * * *